

Table 2. General Response Actions and Potential Applicable Technologies - Soil

General Response Action			Remedial Technology Type	Process Option	Description	Effectiveness	Implementability	Cost	Potential for Retain for Further Evaluation		
No Further Action			None	None	No further action to address contaminated soil and sediment.	Will not address the remedial objectives.	None	None	Yes as baseline for evaluation process		
Institutional Controls			Access and Use	Land Use Controls	Land use restriction (i.e., deed notice or restrictive covenant) is	Will prevent direct exposure to the contaminants; therefore it will address	Implementable	Low	Yes		
Containment	Consolidation and Capping		Clay Cap, Synthetic Membrane, or Chemical Sealant or Stabilizer		A cap is installed to cover the contaminated area to prevent direct exposure to the contamination. Different materials can be used for the cap and typical materials include clay, synthetic membranes, and	Will prevent direct contact and exposure to the contaminated soil , although it does not remove the source of the contamination. It will address the relevant remedial objectives.	Implementable with commercially available equipment; potential worker and community exposure to dust; administrative controls will be required.	Medium	Not as a stand-alone technology and it is included in containment cell option		
	Excavation and Disposal		Excavation and Onsite Disposal Excavation and Offsite Disposal		Contaminated soil is excavated and placed in a containment cell Contaminated soil are excavated and transported to a permitted	Will prevent direct contact and exposure to the contaminated soil , and Will remove the contaminated soil from the site. It will address the relevant	Implementable with commercially available equipment. Potential worker and Implementable	Medium, but the quantity of the Medium	Yes Yes		
Removal	Excavation and Chemical Oxidation				Oxidizing agents (Fenton's reagent, permanganate, ozone, and hypochlorites) are added into the excavated soil to promote abiotic	Chemical oxidation will destroy the contaminants to become less toxic; however some metals (chromium) may become mobile once being oxidized	Implementable, and a bench scale testing is required to determine oxidant dosage.	High, can be cost prohibitive if the soil contains high organic matter.	No, due to potential mobilization of metals to the groundwater		
	Excavation and Soil Mixing and Stabilization/Solidification				Reagents are mixed with excavated soil by a mechanical mixing	Will stabilize and reduce contaminants' migration. However the treated soil	Implementable with commercially available equipment; treatability study is required	High	No, due to high cost		
	Excavation and Soil Washing				Contaminants in soil are desorbed by using a solution of leaching agent, surfactant, pH-adjustment, or chelating agent to help remove	Will address the remedial objectives by removing the contaminants from the soil	Complex process and produces a large quantity of process water that requires treatment. Acid reagent may be used to remove lead from soil, which increase the	High	No, due to complex implementation and cost		
	Excavation and Thermal Treatment				Heat is applied to the excavated soil to increase the volatility of the contaminants. An off-gas treatment will be used to treat the	Will destroy the contaminants (i.e., lead and PAHs), so it will address the remedial objectives.	Not readily implementable; treatability studies required; significant materials handling; specialized equipment and operators; extended construction/ treatment	High	No, due to complex implementation and cost		
	Landfarming				Landfarming is used for the biological treatment of contaminated soil. It consists of spreading excavated contaminated soil either directly on	Landfarming is typically applicable to nonvolatile and semi- volatile compounds. Biodegradation of PAHs becomes more difficult as the	Implementable, however it may take a long period of time depending on biodegradation process in the soil.	Low	No due to ineffectiveness for PAHs with more aromatic rings and lead		
	In Situ				Contaminated soil is mixing in place with reagents to form a solid	May stabilize both organic and metal contaminants. Will need institutional	Implementable with commercially available equipment; treatability study is required	High	No due to high cost		
	Phytoremediation				Plants are used to remove, transfer, stabilize and destroy contaminants in soil. Biodegradation takes place in the soil	Effectiveness of phytoremediation can be seasonal; in some cases it is limited to shallow soil. It is uncertain if the contaminant concentrations are	Implementable	Low	No, due to uncertainty of effectiveness		
NOTE:											
COC = Contaminant of concern			ISTD = In Situ Thermal Desorption			RH = Electrical resistive heating			MNA = Monitored natural attenuation		
CO = In situ chemical oxidation						SVE = Soil vapor extraction			Polycyclic aromatic hydrocarbon		

Table 3. General Response Actions and Potential Applicable Technologies - Groundwater

General Response Action	Remedial Technology	Process Option	Description	Effectiveness	Implementability	Cost	Potential for Retain for Further Evaluation
No Further Action+A4:H12	None	None	No further actions to address contaminated groundwater.	Will not address the remedial objectives	None	None	Yes as baseline for evaluation process
Institutional Controls	Access and Use Restrictions	Groundwater Use Control	Restriction on groundwater use	Will prevent receptors' direct	Implementable, however	Low	Yes
Monitoring	Monitored Natural Attenuation	Monitoring	Groundwater monitoring to	Will be effective if the	Implementable	Low	Yes
Containment	Vertical Barriers	Slurry Wall	Trench downgradient of contaminated area excavated	Will not remove or treat the contaminants, although it will	Implementable	Low to Medium	No due to ineffectiveness without other treatment system.
Removal	Removal or Extraction	Pump and Treat	Conventional ground water	May need multiple treatment	Implementable, but the process	Moderate to High	No due to complexity of the treatment
	In situ Biological Treatment	Enhanced Aerobic	Injection of substrate	Effective for organics and will	Implementable, and may require	Low	Yes
	In situ Physical, Chemical Treatment	In situ chemical oxidation (ISCO)	Injection of oxidizing agents (Fenton's reagent,	Will address the remedial objectives, may be effective for	Implementable and require a bench scale testing to determine	Moderate to high, high total organic matter in the soil may cause a higher oxidant dosing and	No due to potential impact to water wells nearby by the chemical injection
		Air Sparging	Air is injected into saturated	Will address the remedial	Implementable for organic	Medium	No due to uncertainty on arsenic
	In situ Physical, Chemical Treatment (continued)	Thermal Treatment	Electrical resistive heating	Will address the remedial objectives for organic volatile	While implementable, it would require a lot of energy	High	No due to high cost and not addressing arsenic.
Treatment							